International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

L.64
(10/2012)

SERIES L: CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

ID tag requirements for infrastructure and network elements management

Recommendation ITU-T L.64

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Summary

Telecommunication networks require the correct allocation of network elements and periodically planned maintenance to deliver services quickly and efficiently, to minimize out-of-service risk and to guarantee service level agreement satisfaction. It is particularly important to focus on the issue of optical-fibre-based infrastructures and the related huge amount of transmitted information. Network elements that undergo allocation and maintenance operations can be of several types and can differ in terms of position, dimensions, services, field work and scheduled times for periodically planned maintenance.

Identification (ID) data technology can be applied to solutions that focus on the proper management of infrastructure and network elements. The ID uniquely identifies an element of interest in terms of its allocation and maintenance.

Recommendation ITU-T L.64 deals with support systems for infrastructure elements management using ID technology, and provides the criteria for ID tag design.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T L.64	2007-02-06	6
2.0	ITU-T L.64	2012-10-29	15

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Recommendation ITU-T L.64

ID tag requirements for infrastructure and network elements management

1 Scope

This Recommendation deals with support systems for infrastructure and network elements management using ID technology for telecommunication networks. In particular, it indicates the criteria for ID tag design in order to be adapted to different applications' requirements.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ISO/IEC 15394] ISO/IEC 15394:2009, *Packaging – Bar code and two-dimensional symbols for shipping, transport and receiving labels*.

[ISO/IEC 15438] ISO/IEC 15438:2006, *Information technology – Automatic identification and data capture techniques – PDF417 Bar code symbology specification*.

[ISO/IEC 16022] ISO/IEC 16022:2006, *Information technology – Automatic identification and data capture techniques – Data Matrix bar code symbology specification*.

[ISO/IEC 18000-1] ISO/IEC 18000-1:2013, *Information technology – Radio frequency identification for item management – Part 1: Reference architecture and definition of parameters to be standardized*.

[ISO/IEC 18000-2] ISO/IEC 18000-2:2013, *Information technology – Radio frequency identification for item management – Part 2: Parameters for air interface communications below 135 kHz*.

[ISO/IEC 18000-3] ISO/IEC 18000-3:2013, *Information technology – Radio frequency identification for item management – Part 3: Parameters for air interface communications at 13.56 MHz*.

[ISO/IEC 18000-4] ISO/IEC 18000-4:2013, *Information technology – Radio frequency identification for item management – Part 4: Parameters for air interface communications at 2.45 GHz*.

[ISO/IEC 18000-6] ISO/IEC 18000-6:2013, *Information technology – Radio frequency identification for item management – Part 6: Parameters for air interface communications at 860 MHz to 960 MHz General*.

[ISO/IEC 18004] ISO/IEC 18004:2006, *Information technology – Automatic identification and data capture techniques – QR Code 2005 bar code symbology specification*.

3 Definitions

For the purpose of this Recommendation, the definitions given in [ISO/IEC 15394], [ISO/IEC 15438], [ISO/IEC 16022], [ISO/IEC 18000-1], [ISO/IEC 18000-2], [ISO/IEC 18000-3], [ISO/IEC 18000-4], [ISO/IEC 18000-6] and [ISO/IEC 18004] apply.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

DB	Database
GSM	Global System for Mobile communication
HF	High Frequency
ID	Identification (data)
ISM	Industrial, Scientific, Medical
LAN	Local Area Network
LF	Low Frequency
MTBF	Mean Time Between Failures
ODF	Optical Distribution Frame
ODN	Optical Distribution Network
OSS	Operations Support System
PDA	Personal Digital Assistant
PON	Passive Optical Network
QR	Quick Response
RFID	Radio Frequency Identification
UHF	Ultra High Frequency

5 Conventions

None.

6 Identification data

6.1 General requirements for ID

1) ID should be unique.
2) ID should be capable of being read easily.
3) ID should be capable of being input into an OSS when intended target elements are installed and when they are connected or disconnected.
4) ID should not include facility information. ID should only have information that can be converted to facility information in the facility database over an OSS.

6.2 ID tag

ID tags are ready to be mounted on the network element or already provided as an embedded tag.

They should be permanently mounted on the network element or in such a manner that makes them difficult to remove.

ID tags may be based on either the QR code defined in clause 6.2.2, or on electronic ID which may have two implementations such as RFID (an example of non-contact-type ID) defined in clause 6.2.1 and/or contact-type ID defined in clause 6.2.3.

6.2.1 RFID tag

RFID tags usually consist of three parts: chip, antenna and case. They are different for several sets of features: physical, electrical, chemical, mechanical and thermal characteristics. Since in network telecommunication infrastructure and network elements the environmental conditions are quite different, it is impossible to define a unique kind of RFID tag suitable for all the applications. Consideration is needed in order to provide an appropriate solution or solutions for differing networking element ID requirements.

Appropriate applications for RFID are when hostile environments affect the long-term durability and readability of visible text or barcode data, and/or the ID data set is large.

6.2.1.1 Frequency

The frequency spectrum available for in-field implementation is not homogenous worldwide.

LF band (less than 135 kHz) is recommended for traditional RFID application where a low transfer rate and small tag memory are acceptable. It is recommended to check for the presence of other technologies in the same band (i.e., ISDN transmission).

ISM HF band (13.56 MHz) is recommended for short-range RFID applications and provides excellent immunity to environmental noise and electrical interference. This is the typical condition in maintenance activities where reader antennae can be moved very close to the tag. It is recommended to check for the presence of other technologies in the same band (i.e., VDSL plan 998).

UHF band (860-960 MHz) is recommended for logistic applications where fixed antennae must read moving tags automatically and anti-collision for parallel tag reading must be supported. It is recommended to check for the presence of other technologies in the same band (i.e., GSM).

ISM microwave band (2.45 GHz) is recommended for long-range applications where, for security reasons or other causes, tags cannot be directly attached to the network element or where direct access to network element/tag must be avoided. It is recommended to check for the presence of other technologies in the same band (i.e., wireless LAN).

6.2.1.2 Power supply

In short-range applications (LF and HF bands), the use of maintenance-free passive tags (no battery) is recommended. In long-range applications (UHF and microwave bands), (semi-)active tags are typically used in order to achieve transmission between a tag and reader.

6.2.1.3 Transmission distance

In short-range applications (LF and HF bands) transmission distance is not an issue, although metallic substrates can greatly reduce the read distance unless compensatory tuning is applied to tags. It is recommended that the tag be readable even through a protective plastic cover, where one is present. Short-range transmission at 13.56 MHz requires a low force magnetic field that causes no disturbance to other circuits and which avoids undesired tag reading (this needs testing/confirmation that there is no interference risk to VDSL, especially plan 998-12 MHz used in USA).

In long-range applications (UHF and microwave bands), it is recommended to check for possible interference in the wave propagation direction.

6.2.1.4 Tag reading discrimination

Tags situated in very close proximity to each other can result in misreading the intended individual tag and capturing an adjacent tag. This situation can readily arise with cable sheaths in congested areas. Consideration should be given to appropriate designs of scanning head/antenna to eliminate this risk.

6.2.1.5 Data storage

It is recommended that the RFID tag be provided with a non-volatile memory chip embedded. Memory must be sized in order to store all appropriate information. The data structure should be determined by users for their applications.

It is recommended that memory be readable and writable in order to allow upgrade of the content, as a result of maintenance actions.

In the presence of confidential data stored on the tag, it is recommended to consider and solve security issues.

Data stored on the tag can be used to certify in-field activity deployment.

Data stored on the tag allow in-field operators to retrieve information.

6.2.1.6 Case

The tag case performs the double function of chip protection and tag adaptation to the network element where it must be attached.

It is recommended that new network elements be supplied with an embedded tag. This solution facilitates and quickens the deployment of the RFID-based network element management system.

This may require the development of new design solutions to allow for the integration in cables. This solution should reduce the risks to operators of protruding tags.

In indoor applications, it is recommended that the RFID tag case provides protection against water and dust and that it remains readable if mounted on a metal surface.

In outdoor applications, it is recommended that the RFID tag case provide protection against water, dust and UV rays and that it remains readable if mounted on a metal surface. Mechanical impact and crush resistance is required for external use, such as underground joint housings, where they may be stood on.

Consideration should be given to the protection from electromagnetic trauma such as lightning strikes, and ensuring adequate isolation from any electrical ground path.

In particular, environmental conditions where chemical substances are present, further protection is recommended.

The use and design of stand-alone tags should consider the safety of operators from protrusions on network elements.

Tags must be easily detectable and accessible by the operator during maintenance activities throughout the life expectancy of all their future networks. These aspects must be considered both when a stand-alone tag is attached and when a network element is designed with an embedded tag.

6.2.1.7 Environmental conditions and mechanical stress

It is recommended that an adequate operating temperature range be considered according to the different environmental conditions where RFID tags can be used. Tags should be tolerant of likely vibration sources such as powered equipment, road/rail traffic and civil works.

Application to movable network elements, such as cables, will impose flexing and other stresses to tags. There may be instances where tight curvatures are required of an inlay assembly when applied to a small diameter cable sheath, resulting in varying mechanical stress to the chip and its antenna connections.

6.2.1.8 Data retention and MTBF

Data retention and MTBF of RFID tags should be designed by taking the life expectancy of the network elements into consideration.

6.2.1.9 Installation

For stand-alone tags, it is recommended that cases be provided with adequate mechanical characteristics and material properties that are suitable for installation by means of external tools or adhesive components. It is highly desirable that fastenings be irremovable and tamperproof to ensure record continuity for the life expectancy of the network element.

It is recommended to avoid, if possible, tag installation on or near metallic parts of network elements.

Tags should be permanently mounted on the network element or in such a manner that makes them difficult to remove.

6.2.2 QR code tag

6.2.2.1 Notation

The specification of the QR code should be in accordance with [ISO/IEC 18004].

It is recommended that the QR code be printed on a tag, sticker or the element's body.

6.2.2.2 Durability

The QR code should be difficult to erase or remove from a tag, sticker or the element's body.

6.2.2.3 Construction of tag

The tag construction and dimensions should not adversely affect maintenance work.

Tags should be permanently mounted on the network element or in such a manner that makes them difficult to remove.

6.2.2.4 Environmental conditions

The QR code printed on the tag, sticker or element's body should not change shape, be damaged or become blurred under the environmental conditions in which elements are installed.

6.2.3 Contact-type ID tag

6.2.3.1 Tag structure

The contact-type ID tag has metal pins mounted on a network element. When the tag is connected to its corresponding contact-type ID tag or electrode plate mounted on ODN equipment, the data from the contact-type ID tag are transmitted to the appropriate user management system.

The tag construction and dimensions should not adversely affect maintenance work.

Tags should be permanently mounted on the network element or in a way that makes them difficult to remove.

6.2.3.2 Data storage

ID data are permanently stored in the contact-type ID tags. The memory of a contact-type ID tag is written or read by using specific external tools.

6.2.3.3 Environmental conditions

With regard to the environmental conditions where network components are placed, a contact-type ID tag must be tolerant to the same environmental conditions as ODN equipment. Its electrical and mechanical characteristics must always be well maintained.

Appendix I

Italian experience: RFID tag solution for telephony poles

(This appendix does not form an integral part of this Recommendation.)

In Italy, RFID technology for maintenance support has been tested on the poles (almost all wooden) used in the wireline access network throughout the country.

The first step was to trace the in-field maintenance actions and to collect more information on these items in order to better understand the factors that affect pole life expectancy. On the one hand, better knowledge of the poles' network means avoiding random and massive monitoring actions, better spare parts management and network planning. On the other hand, information maintenance can be certified because the tag is on the pole and stores information of the latest actions (date, operator code, etc.).

Typical periodical maintenance requires checking all poles within a network area. More than 40'000 poles were checked in the areas of several networks spread across the national territory.

The kind of item to be tagged and the operating environmental conditions required a special tag design.

The tag is [b-ISO/IEC 14443-x] type B (proximity standard) compliant operating in the ISM band of 13.56 MHz. Short-range reading is not an issue because an operator can move his PDA very close to the tag (few centimetres). The non-volatile embedded memory is a 4 kbit/s EEPROM with a write protection feature. Memory size allows data storing according to the information reported in Table I.1.

Table I.1 – Data structure for telephony poles

Site information	Geographical coordinates
	Network area
Element characteristic	Production year
	Material
	Length
	Capacity
Installation characteristic	Type
	Area
	Ground
	Presence of hanging strands
	Presence of any box
	Presence of grounding system
Check	State of conservation
	Result
	Maintenance actions
	Date
	Operator

Since the memory is rewritable, the operator, after in-field maintenance, can update the data content.

The tag contains a unique 64-bit code that is used to identify the corresponding pole.

The operating temperature range (from –30°C to +85°C) and the maximum number of read/write cycles (10^6) greatly satisfy application requirements.

Typical data retention for commercial tags is beyond 10 years and the average life expectancy of a wooden pole is about 20 years. So data retention was tested using a climatic chamber simulating an ageing process of more than 20 years. At the end of the simulation, memory content was read in all the tested tags.

Since tags must be affixed to the curved pole surface, commercial solutions are not suitable. The project was to design a case to contain the tag, typically delivered in plastic "film and reel" format. The bending radius depends on both the pole height and the position of the tag on the pole itself. The case is designed in order to fit the pole surface and to prevent film bending that could damage the copper elements in the tag. Double fixing points in the horizontal direction preserve the position of the tag even in the presence of cracks in the wood. The solution is illustrated in Figure I.1.

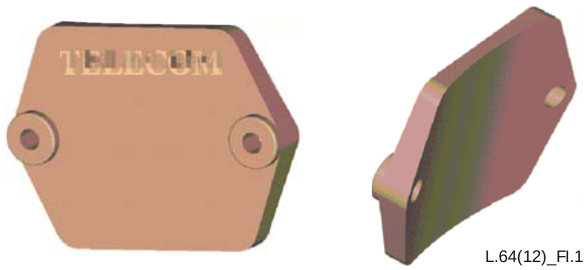


Figure I.1 – Tag case design

A polycarbonate with glass fibre casing is used in order to guarantee secure fixing on wooden poles using screws or nails, even with tools such as electric screwdrivers or nail guns. On glass-fibre poles, tags can be glued using the large surface at the back of the tag. The climatic chamber is also used to test glue performance. Installation on wooden poles is illustrated in Figure I.2.

Figure I.2 – Tag installation

The described tag is intended for in-field installation on poles, but it has also been tested to be embedded in poles. High-pressure chambers are typically used to inject preservative substances deep inside wooden poles in order to ensure they work for many years in difficult environmental conditions. Tags have been tested in this process with positive results, with no damage to the case, electronic circuits or data content.

Appendix II

Japanese experience: Administration system for optical fibres in a central office and access network

(This appendix does not form an integral part of this Recommendation.)

II.1 Introduction

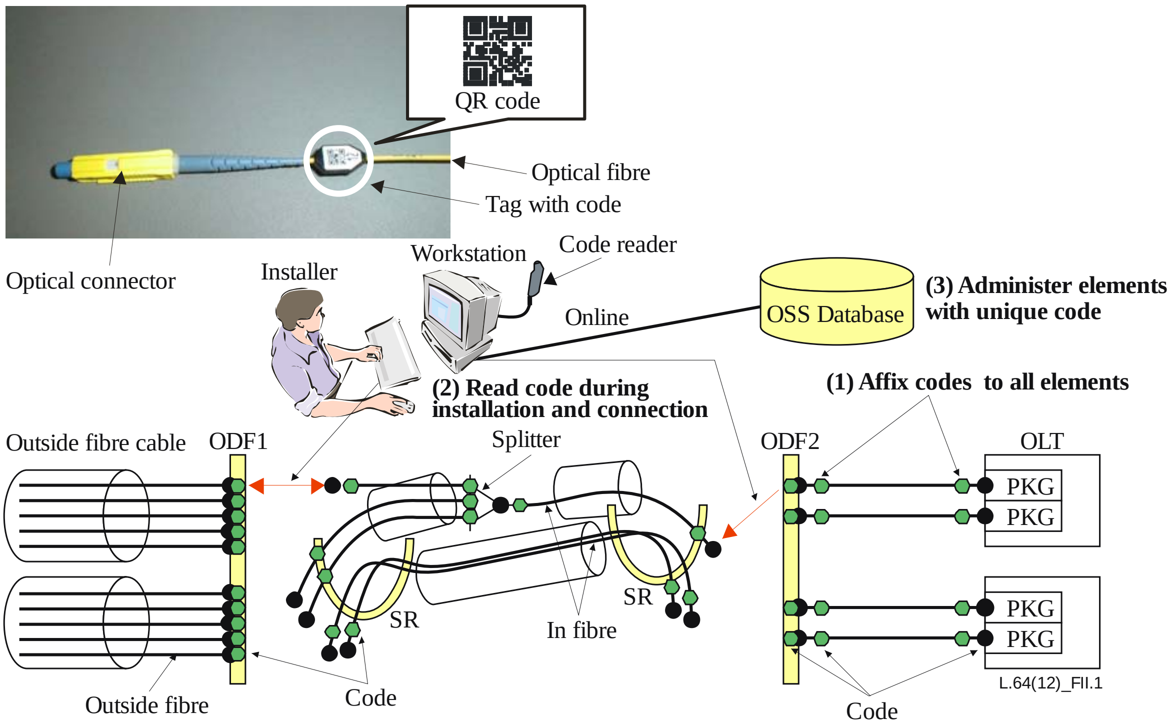
Many systems are being developed in the optical access network field, including fibre-to-the-home and hybrid fibre-coax systems, and many network services are being provided that use these systems.

However, to provide these network systems more quickly and cost-effectively, we need an operations support system (OSS) that uses network elements effectively and increases the speed at which services are delivered to customers. An OSS is important for both customers and carriers because it has a great effect on both user convenience and carrier competition.

II.2 Outline

This appendix describes a mature system. We introduce an administration system for optical fibres in a central office with the aim of managing a huge quantity of in-house equipment using a two-dimensional code (Figure II.1):

1) Every element that is an administrative target has a unique distinguishing code affixed to it. For example, a fibre has a code at each end and a splitter adapter has a code on each receptacle. These distinguishing codes are in a specific order and are mechanically affixed to elements when they are manufactured at the factory. This means that the installer is not required to affix a code to the elements.
2) The code is read electronically with a code reader and passed to the OSS when the intended target elements are installed and when they are connected or disconnected.
3) The OSS can then administer each target element.



ODF Optical distribution frame
PKG Package
SR Standby rack
OLT Optical line termination
OSS Operations support system

Figure II.1 – Administration using a distinguishing code

II.3 Function

II.3.1 Function of installation administration

1) When installing an element, such as a fibre or splitter, the installer reads the affixed distinguishing code with a code reader (Figure II.2).

2) The OSS receives the element information and stores it in a database, using the code as a key attribute.

Consequently, this technique creates a precise link between the elements and the element information in the OSS database.

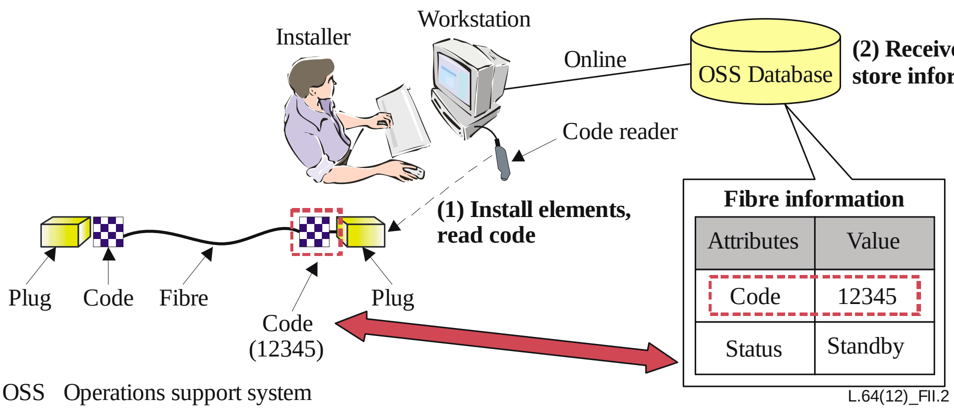


Figure II.2 – Installation administration

II.3.2 Function of connection administration

1) When connecting a fibre plug to a splitter adapter receptacle, for example, the installer reads the distinguishing codes on both the plug and the receptacle (Figure II.3).

2) The OSS enters this set of codes in its database.

Precise information based on the relationship between the codes is thus stored in the database. This administration process would be executed by a service order to ensure that the appropriate elements are allocated effectively.

Moreover, with this process, the system can support the installer because it can detect the current state of the installation by reading the distinguishing codes in real time. Hence, the installer can be provided with pertinent information, such as the next task.

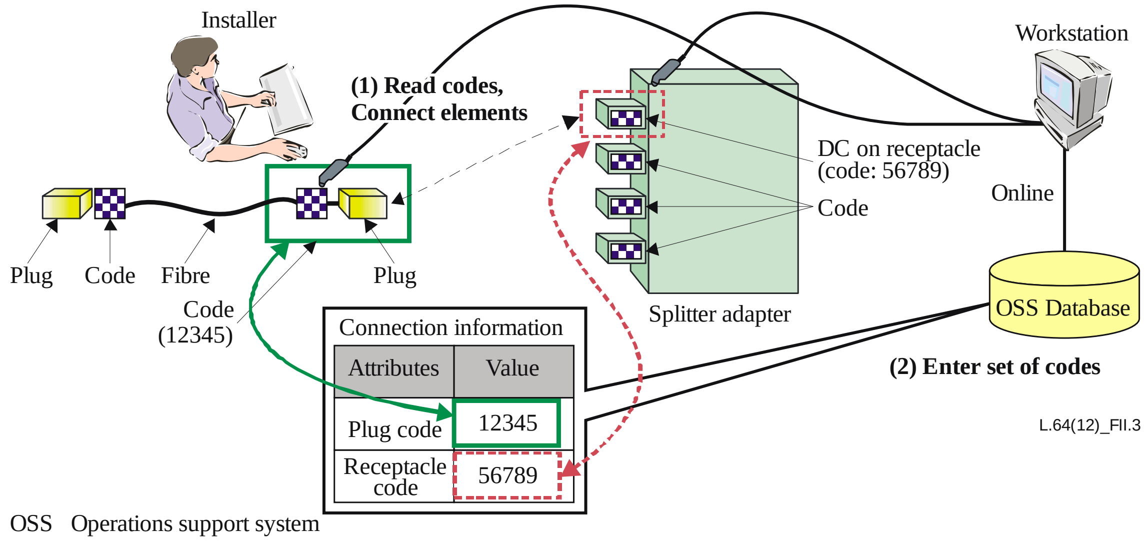


Figure II.3 – Connection administration

II.3.3 Function of connection verification

1) In the example shown, an order to connect a fibre plug with a code of "12345" to a receptacle on a splitter whose code "56789" had been previously entered in the OSS. The installer first reads the codes on the fibre plug and the receptacle (Figure II.4).

2) The OSS then verifies that the codes match those on the order.

3) If they match, the OSS advises the installer to make the connection. If they do not match, the OSS advises the installer to double-check that the codes have been read from the correct elements.

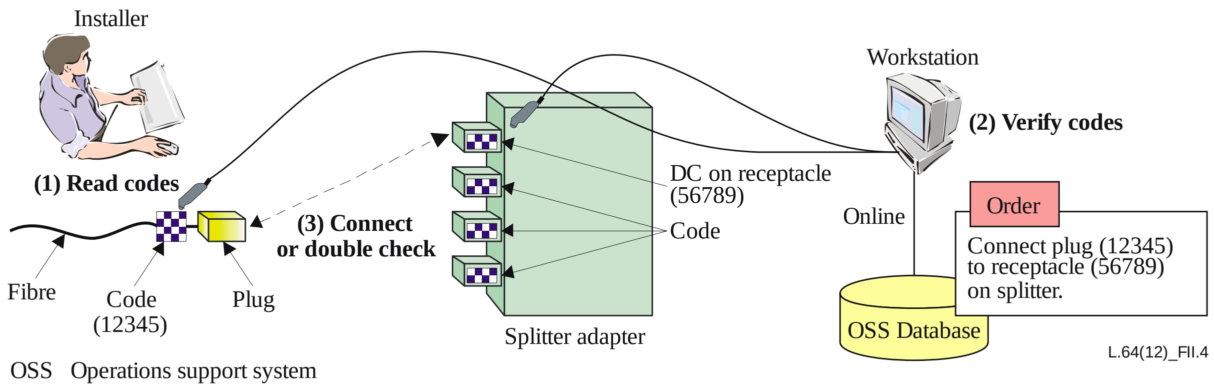


Figure II.4 – Connection verification

II.3.4 Function of removal verification

1) In the example shown, an order to remove a fibre plug with a code of "12345" from a receptacle on a splitter with a code of "56789" had been previously entered into the OSS. Before removing the plug from the receptacle, the installer reads their codes (Figure II.5).

2) The system verifies that the removal target matches that on the order.

3) If there is no match, the system warns the installer not to remove the plug. If there is a match, the installer is advised to proceed with the removal.

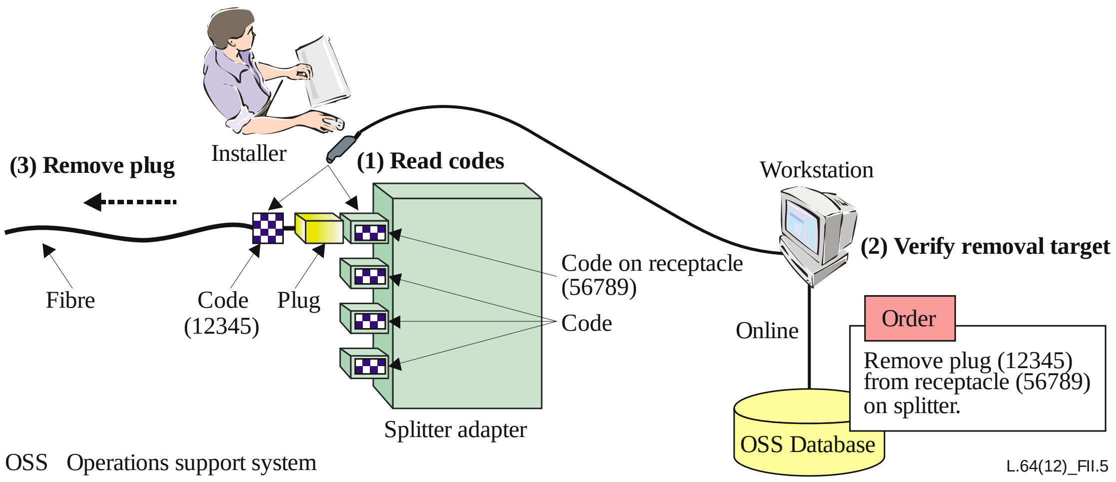


Figure II.5 – Removal verification

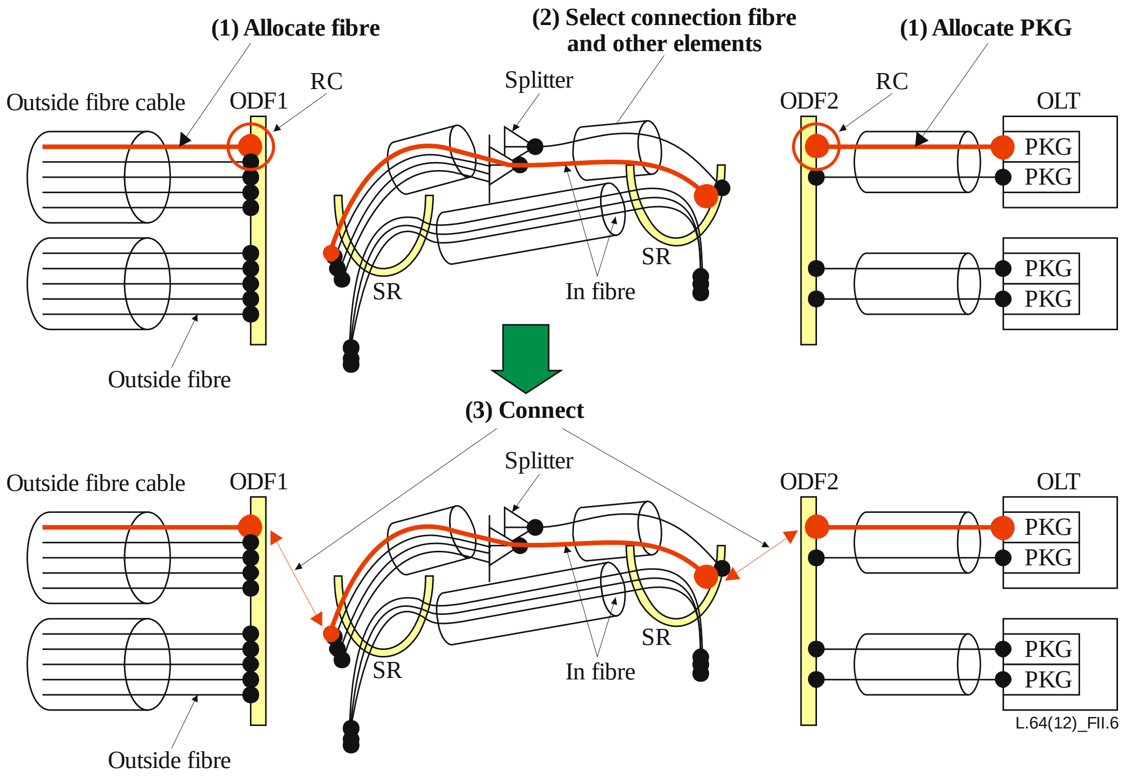
II.3.5 Function of in fibre allocation

1) The first step is to allocate an outside fibre and a device package (Figure II.6).

2) The outside fibre is allocated based on the customer's address, and the device package is allocated based on the type of service to be provided. Receptacles that correspond to the allocated elements are allocated on two connection racks. Next, connection fibres and other elements that make it possible to connect the receptacles on the two racks are selected based on the type of service.

3) Then, the connection fibres and elements are connected between the connection racks.

As mentioned in the introduction, the effective allocation of suitable elements is very important in terms of cost reduction. By "effective allocation" we mean the ordered and quick allocation of appropriate elements.



ODF Optical distribution frame
PKG Package
RC Receptacle
SR Standby rack

Figure II.6 – Fibre allocation

II.3.6 Function of maintenance

This function shares database (DB) and related information with the optical fibre maintenance support system.

Appendix III

Chinese experience I: An intelligent ODN system

(This appendix does not form an integral part of this Recommendation.)

III.1 Introduction

As the ODN scale expands, an increasingly large number of optical fibres need to be deployed. The passive features of traditional ODNs has led to inaccuracies and low efficiency in construction, service provisioning and maintenance with the following major flaws.

1) There is too much time spent in ensuring that the optical fibres are connected properly by manually checking them.

2) It is not accurate and efficient for the actual optical fibres and ports resources to be synchronized to OSS by manual updating.

3) Once faults occur, there is no effective way to locate faults accurately in time.

An intelligent ODN system is developed hereby to address the major issues of a traditional ODN system listed above.

An intelligent ODN system includes intelligent ODN equipment, an intelligent field tool, management system and OSSs. It is suggested to use the management system to manage ID data in a unified manner. The data in the ID tag used in the intelligent ODN is collected by the intelligent field tool, and then uploaded to the management system. Also, ID data can be uploaded to the management system directly, as illustrated in Figure III.1.

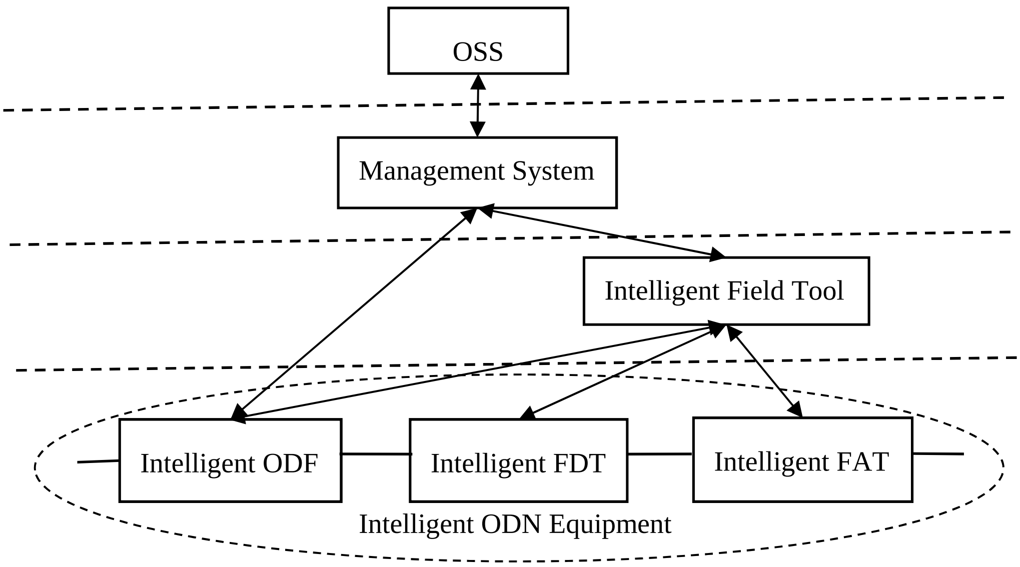


Figure III.1 – Example of intelligent ODN system architecture

In intelligent ODN systems, various ID tag technologies including contact-type ID tag and RFID tag can be used for optical fibres identification. Contact-type ID tag and RFID tag can be considered as implementations of an electronic ID tag in that their ID information is stored in electronic chips and read and/or written by an electronic tool.

III.1.1 Contact-type ID tag structure

Figure III.2 shows one possible implementation of a contact-type ID tag structure. A contact-type ID tag, which contains an integrated circuit, is permanently attached to a standard optical fibre connector to be identified. A contact-type ID tag adapter (i.e., port) is fixed to the intelligent ODN equipment. When a contact-type ID tag is inserted into its corresponding adapter, ID data from the contact-type ID tag is transmitted to a management unit associated with the ODN equipment and then transmitted to the management system for further processing.

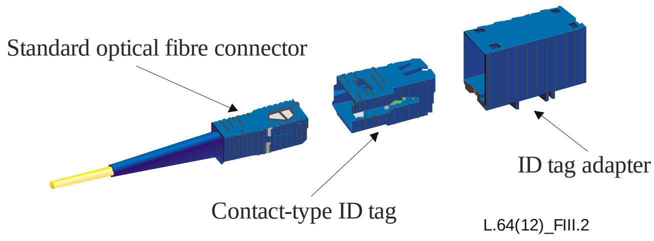


Figure III.2 – An example of contact-type ID tag implementation

III.1.2 RFID tag structure

Figure III.3 shows an implementation of RFID tag structure. An RFID tag, which contains a tag antenna, and a tag chip for ID storage, is attached to a standard optical fibre connector to be identified. An RFID tag adapter (i.e., port) is fixed to the intelligent ODN equipment. When an RFID tag is inserted into its corresponding adapter, RFID tag data is transmitted or updated from an RFID R/W antenna to a management unit associated with the ODN equipment and then transmitted to the management system for further processing.

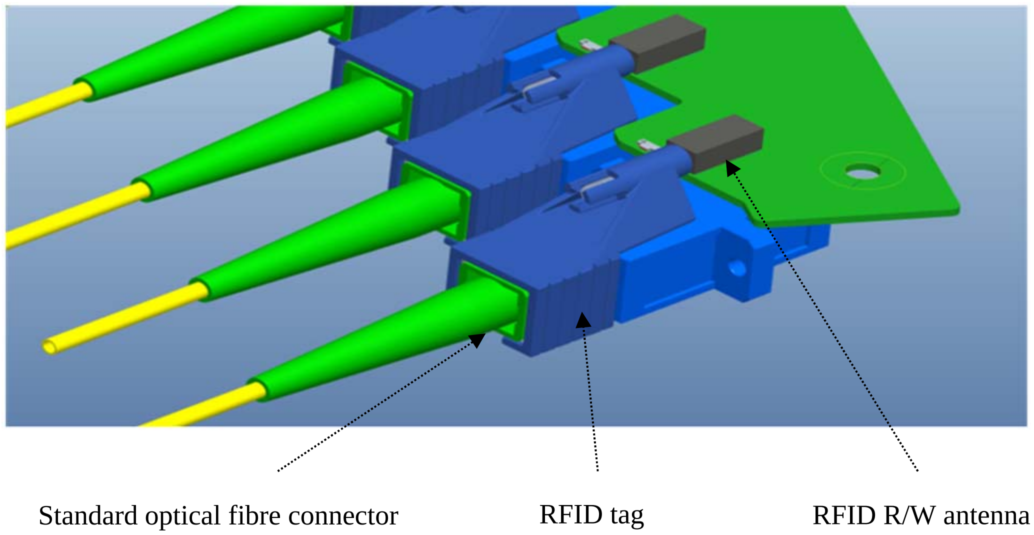


Figure III.3 – An example of RFID tag implementation

III.2 Outline

This clause describes a generalized intelligent ODN system. As a matter of convenience, an intelligent optical distribution frame (ODF) is used as an example to explain how to realize the intelligent management of an ODN by using the electronic ID tags introduced above. This generalized intelligent ODN system is shown in Figure III.4.

1) Intelligent ODF: The optical fibre connector of each component (including the pigtail, the patch cord and the splitter) on the intelligent ODF has an electronic ID tag which can be a contact-type ID tag or an RFID tag. The ID data is unique and written into the chip of an electronic tag in advance. A management unit is used to collect and update electronic ID information.

2) PDA: An intelligent field tool which is interconnected with an intelligent ODF and a management system, driving the intelligent ODF to collect electronic ID information, guiding the in-field operation and verifying optical fibre scheduling automatically.

3) Management system: management of ID information and work orders distribution.

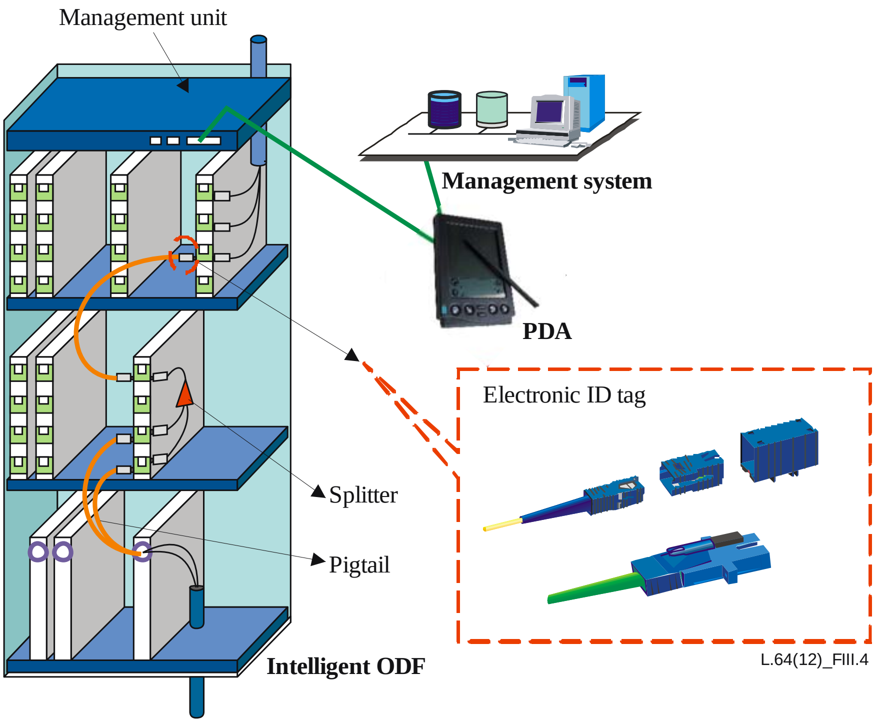


Figure III.4 – Intelligent ODN system using electronic ID tag

As for electronic ID coding, the following information should be included.

Table III.1 – Electronic ID coding

Electronic ID coding		
Connector ID	**Connector information**	**Device ID**
Global unique ID	Connector type: SC/LC, UPC/APC	Patch cord SPL global unique ID
	Port No.: SPL uplink or downlink, 1-…64	

III.3 Functions

III.3.1 Function of guiding patch cord connection

1) When an operator is going to carry out patch cord connection, he uses a PDA to download work orders from the management system. These work orders are presented visually in graphics or tables for easy operation.

2) The operator selects a work order to operate and commands will be sent to the intelligent ODF to light the corresponding ports to be connected. Then, the operator plugs a patch cord with the attached electronic ID tag into the ports indicated.

3) The operator uses the PDA again to collect the ID information of the patch cord inserted into the ports, verifying the correct connection of the patch cord automatically, based on an

analysis of the ID information. If an error occurs, an alarm will be presented to ensure correct operation.

4) The operator uploads the correct operation result to the management system, updating the database of ID information and its related port state automatically.

Consequently, optical fibre scheduling by patch cord connection will be ensured accurately.

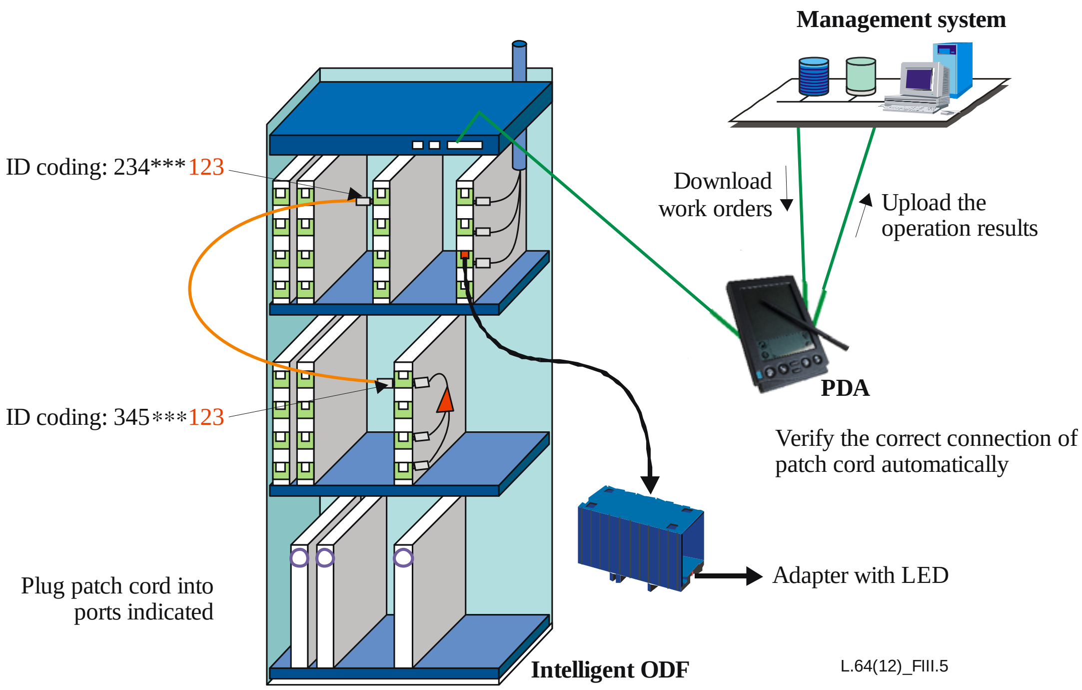


Figure III.5 – Patch cord connection

III.3.2 Function of guiding pigtail connection

1) When an operator is going to carry out a pigtail connection, he uses the PDA to download work orders from the management system. These work orders are presented visually in graphics or tables for easy operation.

2) The operator selects a work order to operate. According to the work order, the operator splices the pigtail attached to the electronic ID tag with optical fibre and then binds the relationship of the pigtail to the optical fibre by using the PDA.

3) The operator uses a PDA to send commands to an intelligent ODF to light the corresponding port to be connected. Then, the operator plugs the pigtail into the port indicated.

4) The operator uses a PDA again to collect ID information of the pigtail inserted into ports, verifying the correct connection of a pigtail automatically based on analysis of the ID information. If an error occurs, an alarm will be presented to ensure correct operation.

5) The operator uploads the correct operation result to the management system, updating the database of corresponding ID information and matching relationships automatically.

Consequently, the matching relationship between the pigtail and port, the matching relationship between the pigtail and optical fibre are well maintained.

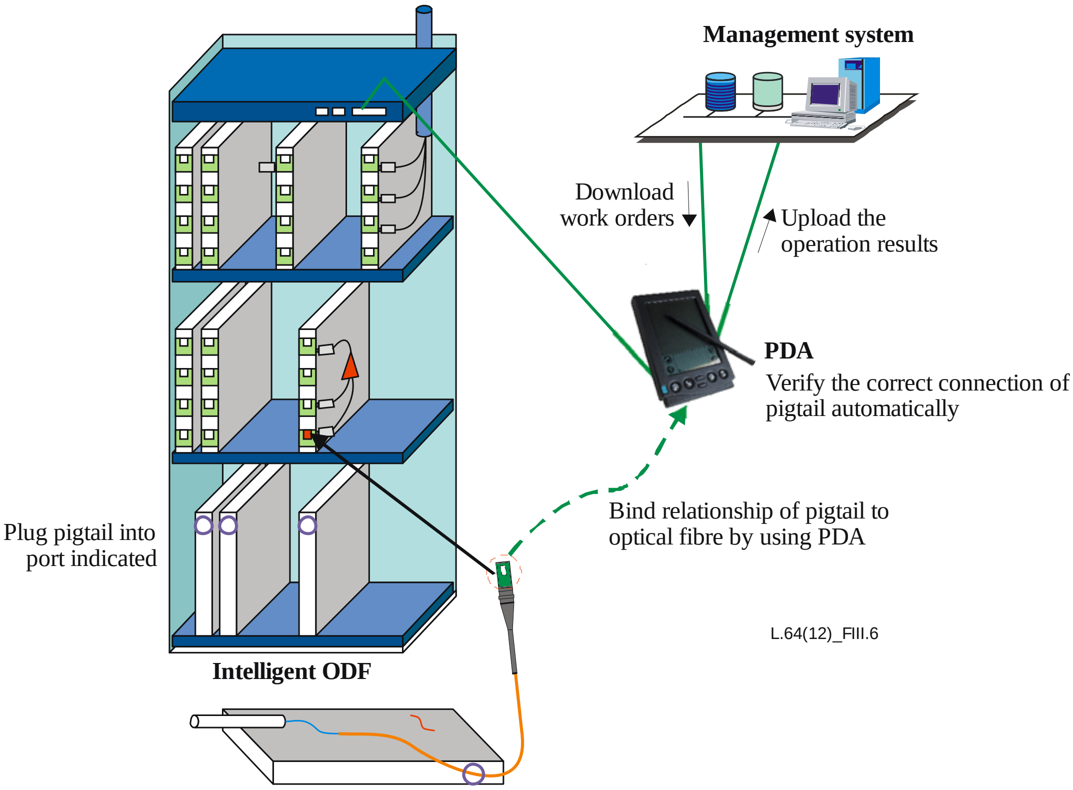


Figure III.6 – Pigtail connection

III.3.3 Function of guiding a patch cord connection between an OLT and an intelligent ODF rack

1) When an operator is going to carry out a patch cord connection between an OLT and an intelligent ODF rack, he uses a PDA to download work orders from the management system. These work orders are presented visually in graphics or tables for easy operation.

2) The operator selects a work order to operate. According to the work order, the operator plugs one end of a patch cord into the corresponding port of the OLT. Then, the operator binds the ID information of the other end of the patch cord attached electronic ID tag with the corresponding port of OLT by using a PDA.

3) When the operator operates at the ODF side, he uses the PDA to read ID information of the other end of the patch cord .Then, according to the work order, commands will be sent to an intelligent ODF to light the corresponding port to be connected. The operator plugs the other end of the patch cord into the port indicated.

4) The operator uses the PDA again to collect ID information of the patch cord inserted into an intelligent ODF port, verifying the correct connection of the patch cord automatically based on an analysis of ID information. If an error occurs, an alarm will be presented to ensure the correct operation.

5) The operator uploads the correct operation result to the management system, updating the database of corresponding ID information and matching relationships automatically.

Consequently, the matching relationship between the patch cord and OLT port, the matching relationship between the patch cord and intelligent ODF port are well maintained.

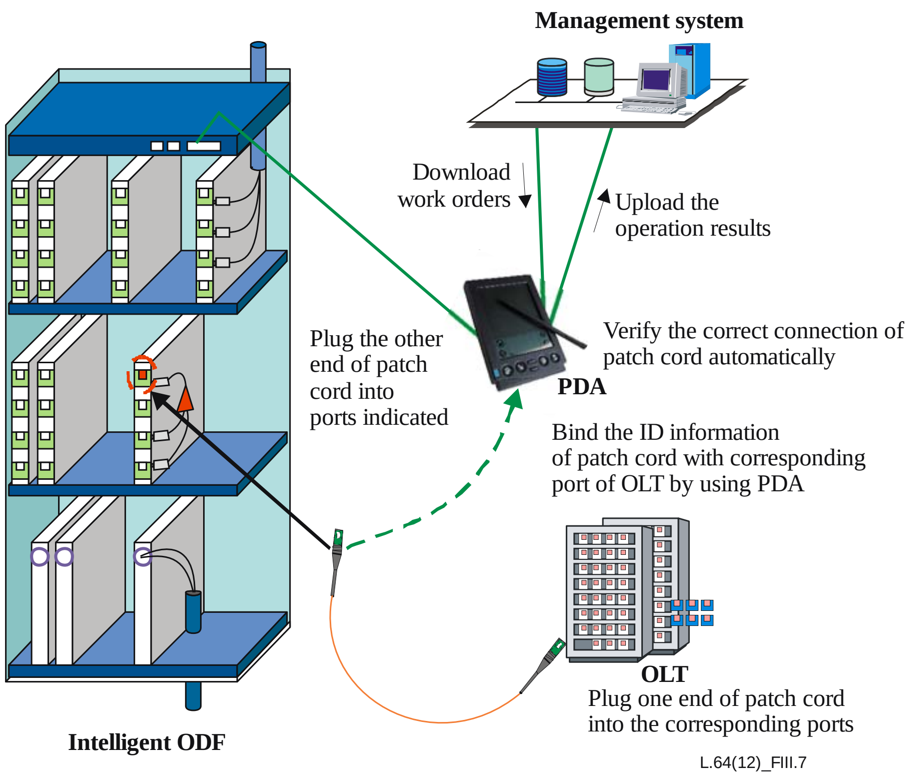


Figure III.7 – Patch cord connection between the OLT and an intelligent ODF rack

III.3.4 Function of optical fibre routing management

ID information and relationships of optical fibre are collected and uploaded to a management system by a PDA automatically. With accurate data, end-to-end optical fibre routing can be generated, which will provide convenience and increased efficiency in terms of service provisioning and maintenance for an intelligent ODN system.

III.4 Conclusion

As intelligent ODN systems reach maturity, they can perform many useful functions of optical fibres routing and management with the use of electronic ID tags that may include contact-type ID tag and/or RFID tag.

Appendix IV

Chinese experience II: RFID tag solution for ODN

(This appendix does not form an integral part of this Recommendation.)

IV.1 Introduction

With the expansion of passive optical network (PON) deployment worldwide, ODN operation including construction, management and maintenance is more and more important and complex with most of the passive components, e.g., fibre, splitter, etc. An RFID tag is used to mark those passive components and their internal connection status information of the ODN. To save time and improve efficiency for associated ODN work, an ID management system proposed by [b-ITU-T L.80] and PDA terminals called eTab are equipped together with an RFID tag to form an integrated system, which in the following is called "eODN", to cover the entire lifespan of ODN operation.

IV.1.1 RFID tag

Figure IV.1 shows an implementation of the RFID tag structure. In the implementation, an RFID tag contains a tag antenna, a tag chip for ID storage and a carrier, which is fixed on the device to be identified. RFID tag data is transmitted or updated from the RFID R/W antenna and R/W tools to the external devices and management systems, in which the RFID R/W antenna and R/W tools can be placed in distribution equipment or external modules.

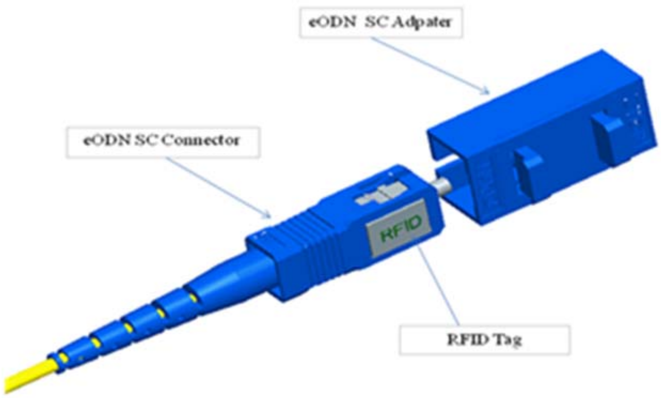


Figure IV.1 – An implementation of an RFID tag

IV.2 Outline

This clause illustrates the eODN solution. An eODN solution consists of three parts:

1) eNode system: includes RFID tags and corresponding R/W antenna and R/W tools. R/W antenna and R/W tools are used to retrieve and update information in the RFID tag memory.

2) eTab: handset tool interconnected with R/W tools in the eNode system and management system, driving the eNode system to retrieve or update RFID information, and drive an eNode system to guide site operation via an indication light.

3) Management system: responsible for managing all tag information and corresponding operation and maintenance command.

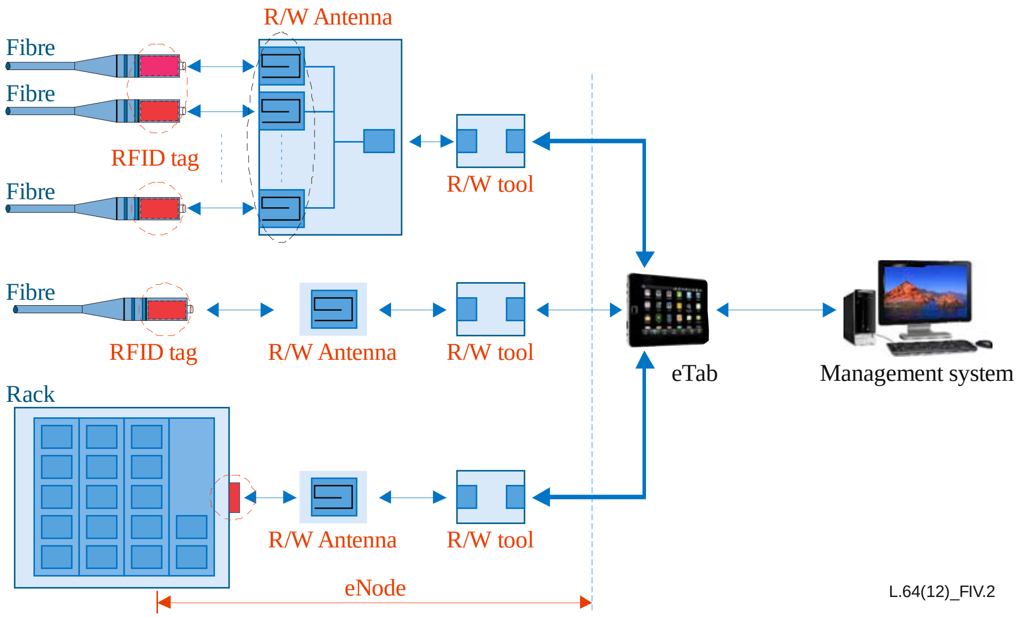


Figure IV.2 – eODN system overview

The RFID tag data structure is shown in Table IV.1.

Table IV.1 – RFID chip data structure

RFID definition				
Front-end A connection relationship		**Component ID**	**Back-end A connection relationship**	
Position information	Connected component information	Global unified ID for each ODN component, and related end identification	Position information	Connected component information

IV.3 Function

IV.3.1 Guide to patch cord connection

1) Download bundled work-orders information from a management system to an eTab terminal.

2) In the eTab, the corresponding equipment information will be analysed and displayed via a visual interface for all work-orders in the bundle. A field engineer then can select one work order to be implemented.

3) The field engineer uses an eTab to enable lighting the corresponding LED of the two ports to be connected, which could guide the field engineer to plug in one patch cord.

4) The field engineer plugs the patch cord into the two ports with LED lighting.

5) The field engineer sets the connection relationship to the port and patch cord, and fills in such connection relationship information in both the RFID of the port and patch cord.

6) The field engineer uses an eTab to check the RFID information of both the patch cord and port with the implemented work order.

7) The field engineer uses an eTab to provide feedback of the operation result to the management system for database updating.

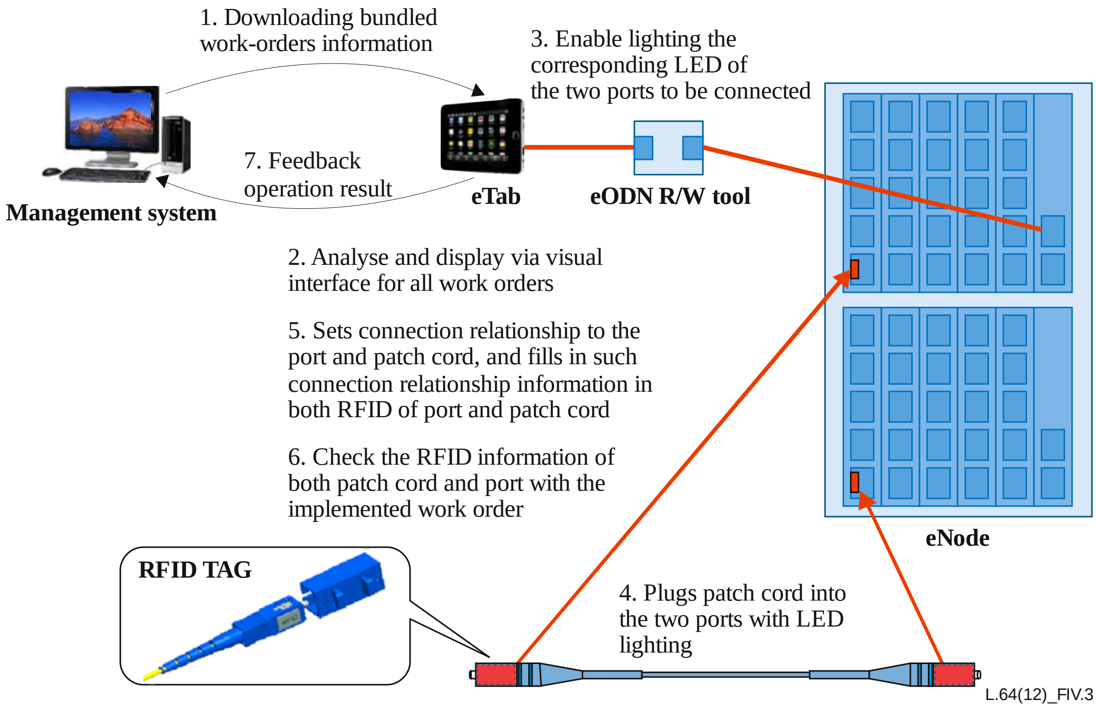


Figure IV.3 – Patch cord connection

IV.3.2 Guide to pigtail connection

1) Download bundled work-orders information from the management system to the eTab terminal.

2) In the eTab, corresponding equipment information will be analysed and displayed via a visual interface for all work orders in the bundle. A field engineer then can select one work order to be implemented.

3) The field engineer assembles one end of the pigtail to the fibre through welding.

4) The field engineer uses the eTab to enable lighting the corresponding LED of the port to be connected, which could guide the field engineer to plug in the other end of the pigtail.

5) The field engineer plugs the other end of the pigtail into the port with LED lighting.

6) The field engineer sets a connection relationship to the port and pigtail, and fills in such connection relationship information in both the RFID of the port and pigtail.

7) The field engineer uses the eTab to check the RFID information of both the pigtail and port with the implemented work order.

8) The field engineer uses the eTab to provide feedback on the operation result to the management system for database updating.

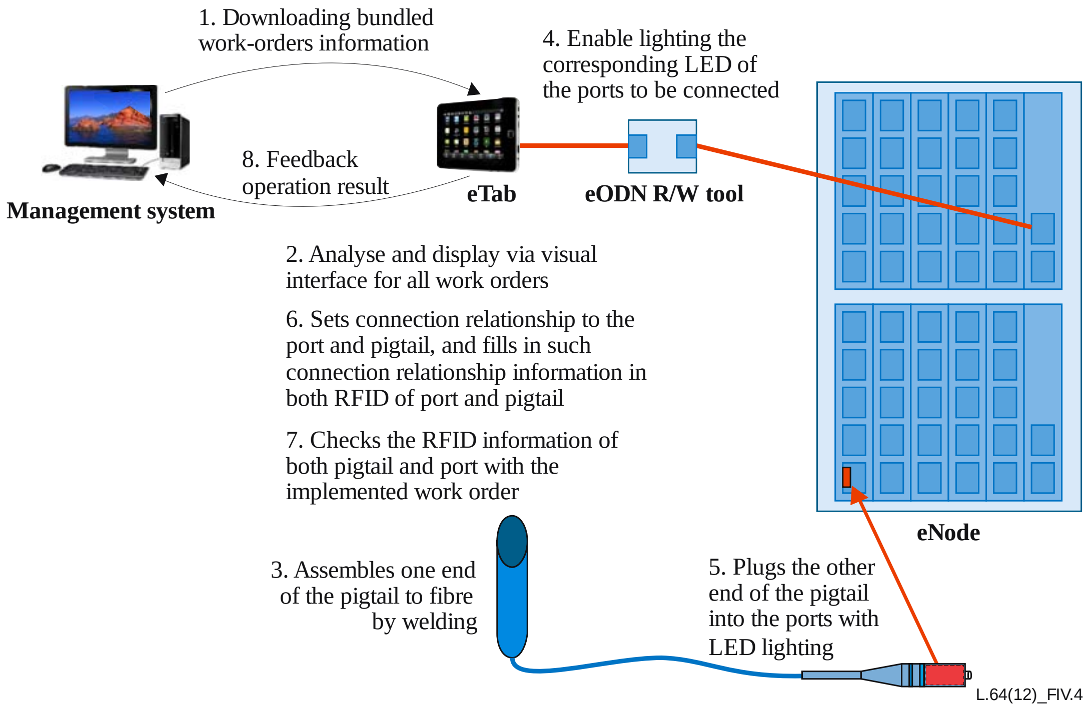


Figure IV.4 – Pigtail connection

IV.3.3 Guide to patch cord connection between an OLT and ODF rack

1) Download bundled work-orders information from the management system to an eTab terminal.

2) In the eTab, corresponding equipment information will be analysed and displayed via a visual interface for all work orders in the bundle. The field engineer then can select one work order to be implemented.

3) The field engineer connects the end of patch cord without an RFID tag to the OLT.

4) The field engineer uses the eTab to enable the lighting of the corresponding LED of the port to be connected in the ODF rack.

5) The field engineer plugs the other end of the patch cord (with RFID) into the port with LED lighting.

6) The field engineer sets a connection relationship to the port and patch cord, and fills in such connection relationship information in both the RFID of the port and patch cord.

7) The field engineer uses the eTab to check the RFID information of both the patch cord and port with the implemented work order.

8) The field engineer uses the eTab to provide feedback of operation result to the management system for database updating.

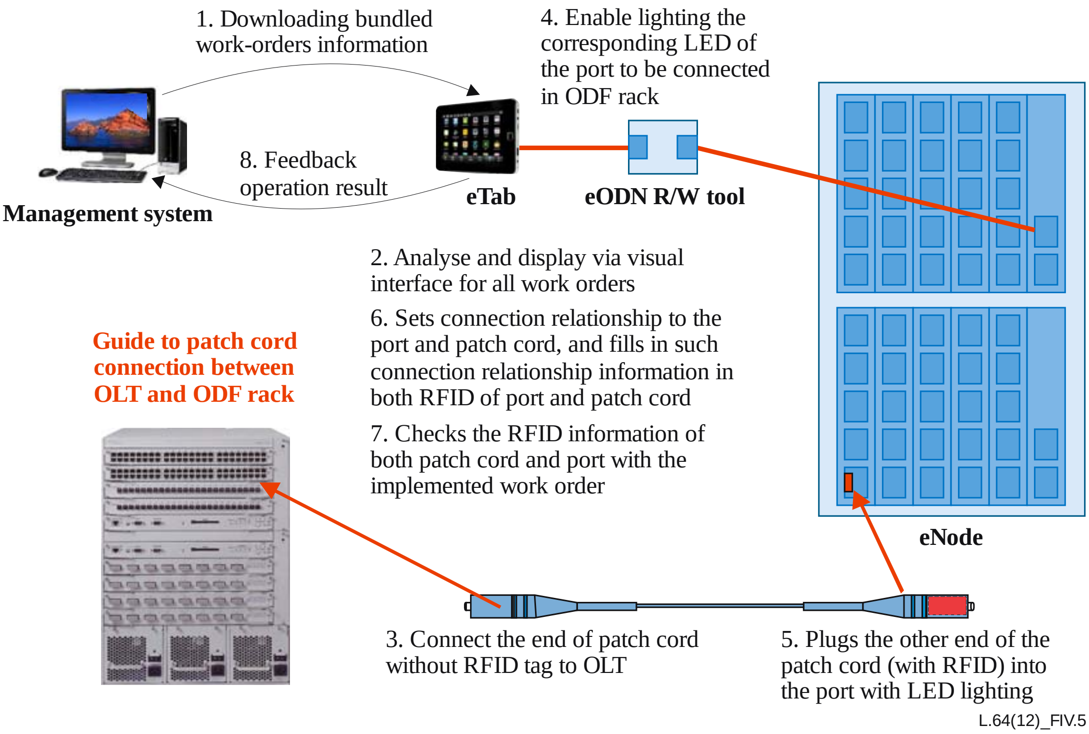


Figure IV.5 – Patch cord connection between OLT and ODF rack

IV.3.4 Guide to connection between the splitter and ports of the splice tray

1) Download. bundled work-orders information from the management system to an eTab terminal.

2) In the eTab, corresponding equipment information will be analysed and displayed via a visual interface for all work orders in the bundle. The field engineer then can select one work order to be implemented.

3) The field engineer uses the eTab to enable the lighting of the corresponding LED of the port to be connected with the input end of the splitter.

4) The field engineer plugs the input end of the splitter into the port with LED lighting.

5) The field engineer uses the eTab to enable the lighting of the corresponding LED of the ports to be connected with the output ends of the splitter.

6) The field engineer plugs the output ends of the splitter into the ports with LED lighting.

7) The field engineer sets a connection relationship to all ports and input/output ends of splitter, and fills in such connection relationship information in both RFIDs of all ports and input/output ends of the splitter via the eTab.

8) The field engineer uses the eTab to check the RFID information of both RFIDs of all ports and input/output ends of the splitter with the implemented work order.

9) The field engineer uses the eTab to provide feedback of the operation result to the management system for database updating.

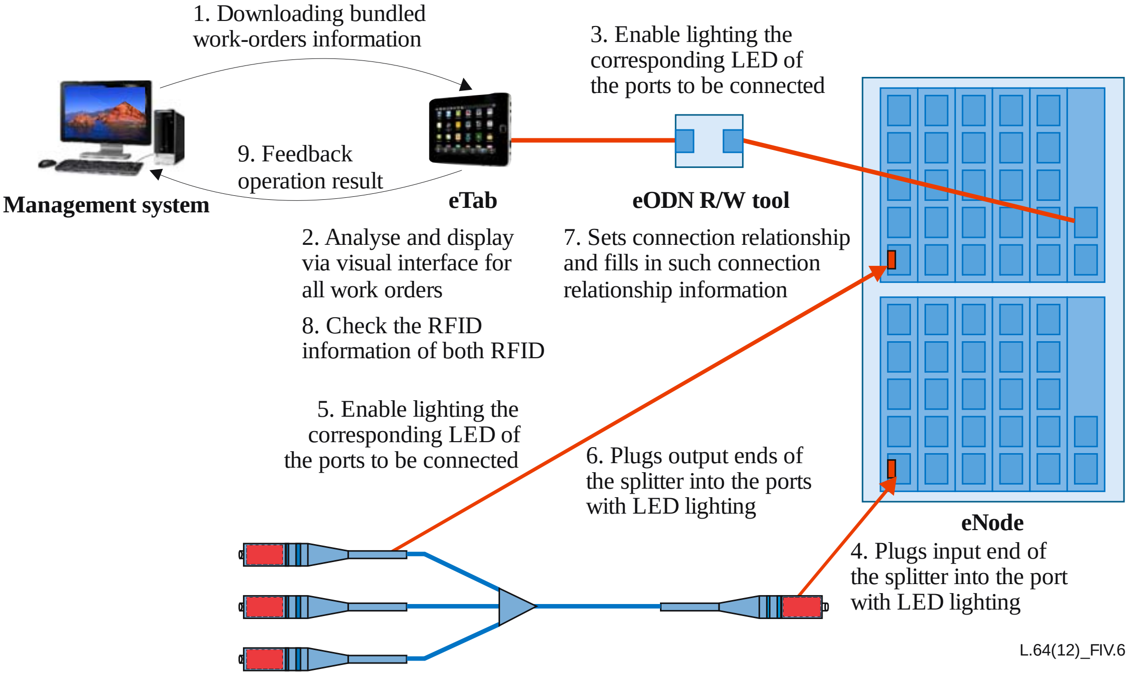


Figure IV.6 – Connection between splitter and ports of splice tray

IV.3.5 Guide to component and connection relationship management

Via the eTab, all RFID information including component information and all connection relationships could be collected and updated to the management system. Then, all configuration maps with RFID information could be generated or updated in the management system accordingly, for further efficient operation or maintenance.

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Printed in Switzerland
Geneva, 2013